000720 01:20560

FIG. 1

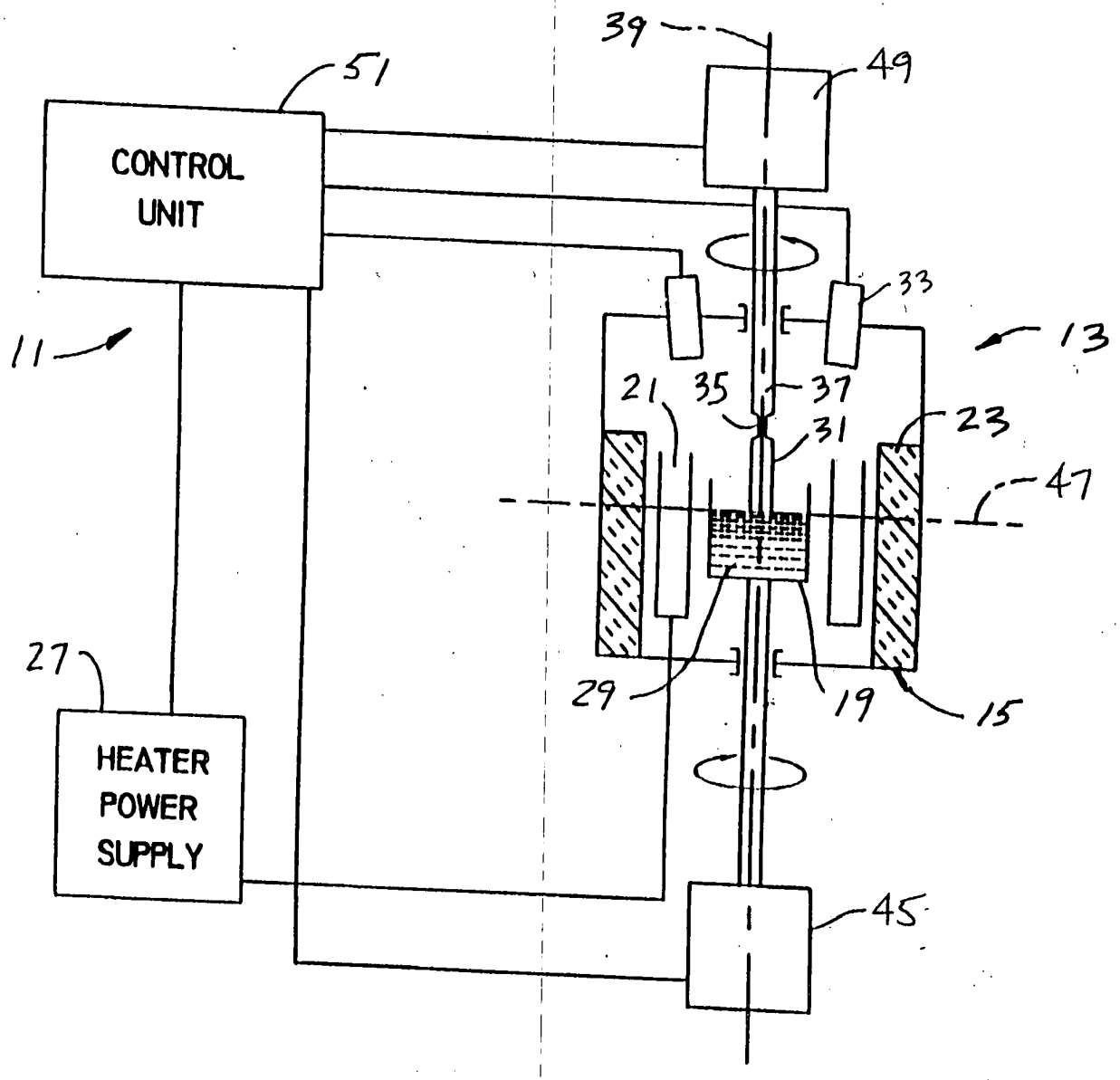

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FIG. 2

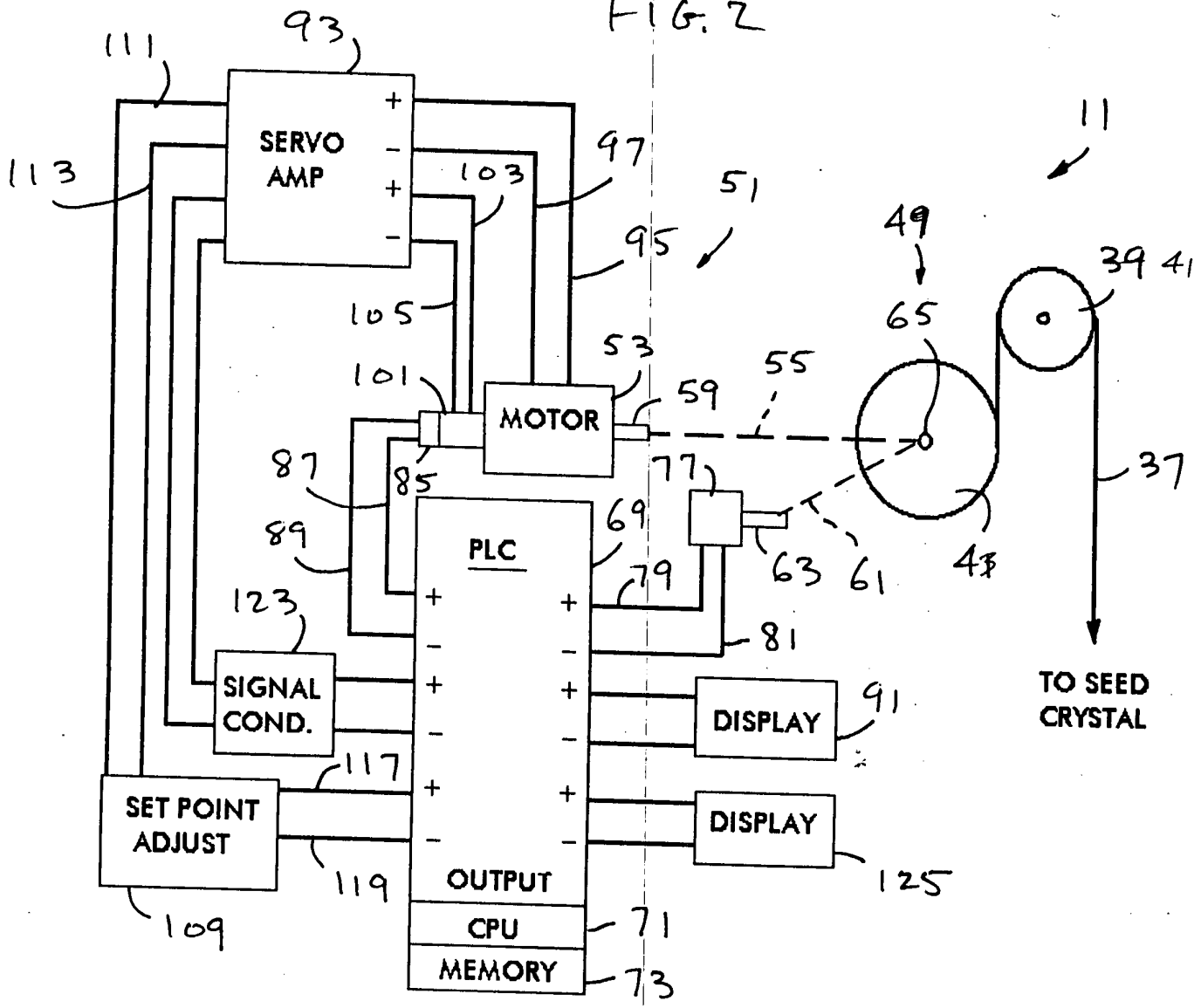
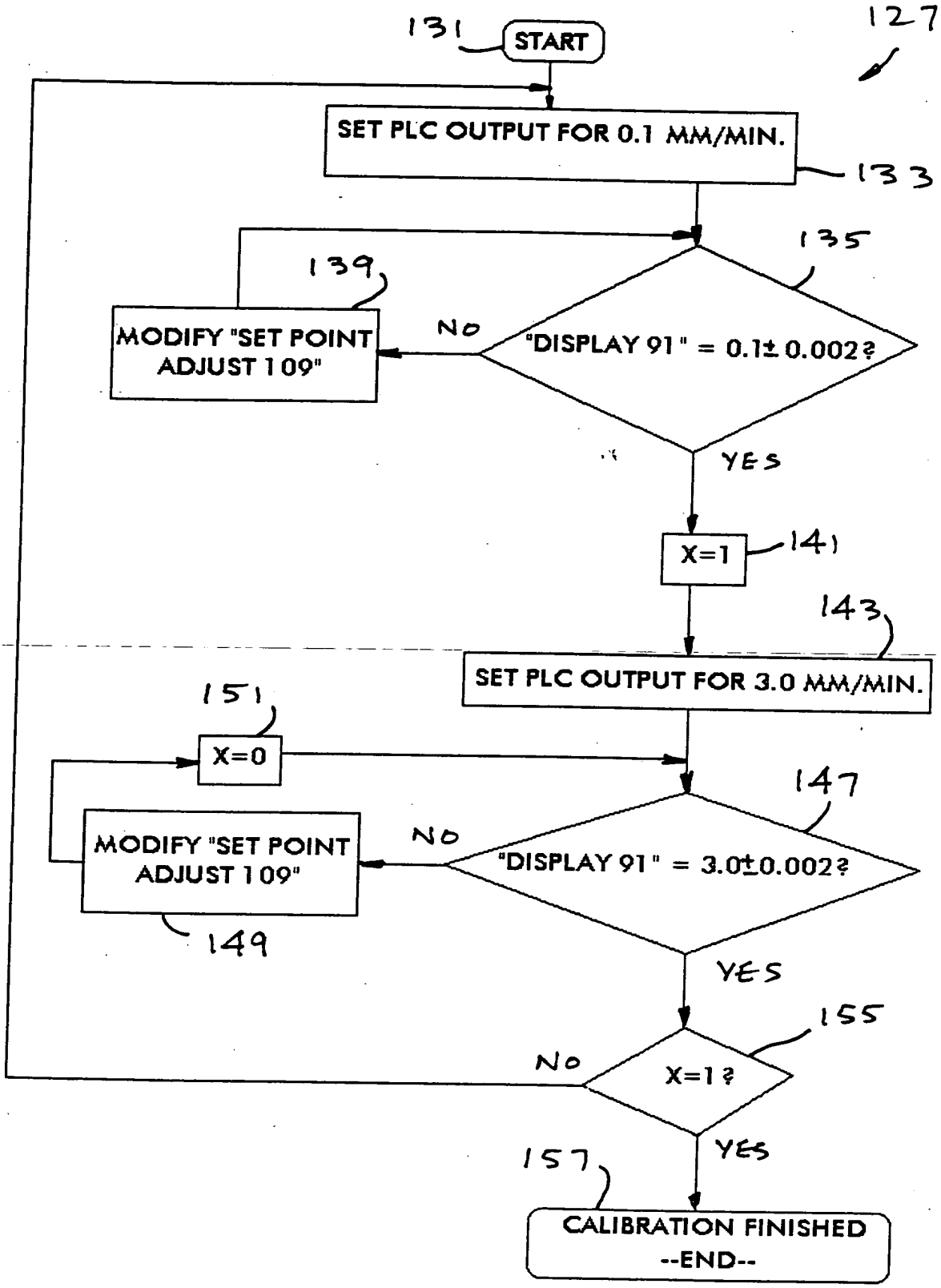


FIG. 3


127
131
START
SET PLC OUTPUT FOR 0.1 MM/MIN.
133
135
"DISPLAY 91" = 0.1±0.002?
NO
139
MODIFY "SET POINT ADJUST 109"
YES
X=1
141
143
SET PLC OUTPUT FOR 3.0 MM/MIN.
151
X=0
147
"DISPLAY 91" = 3.0±0.002?
NO
MODIFY "SET POINT ADJUST 109"
149
YES
155
X=1?
NO
YES
157
CALIBRATION FINISHED
--END--

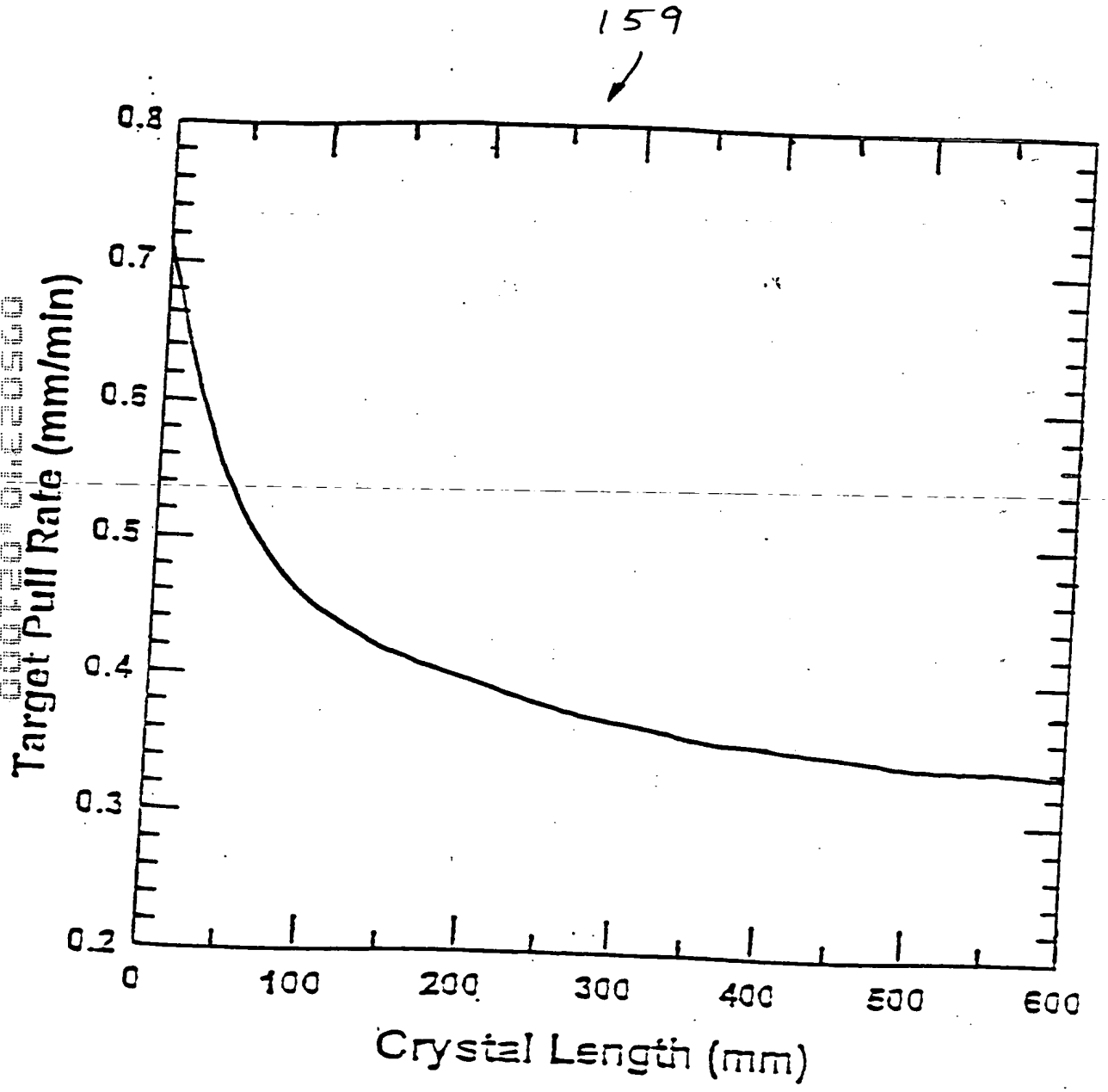

159
0.8
0.7
0.6
0.5
0.4
0.3
0.2
Target Pull Rate (mm/min)
0
100
200
300
400
500
600
Crystal Length (mm)

FIG. 4

FIG. 5

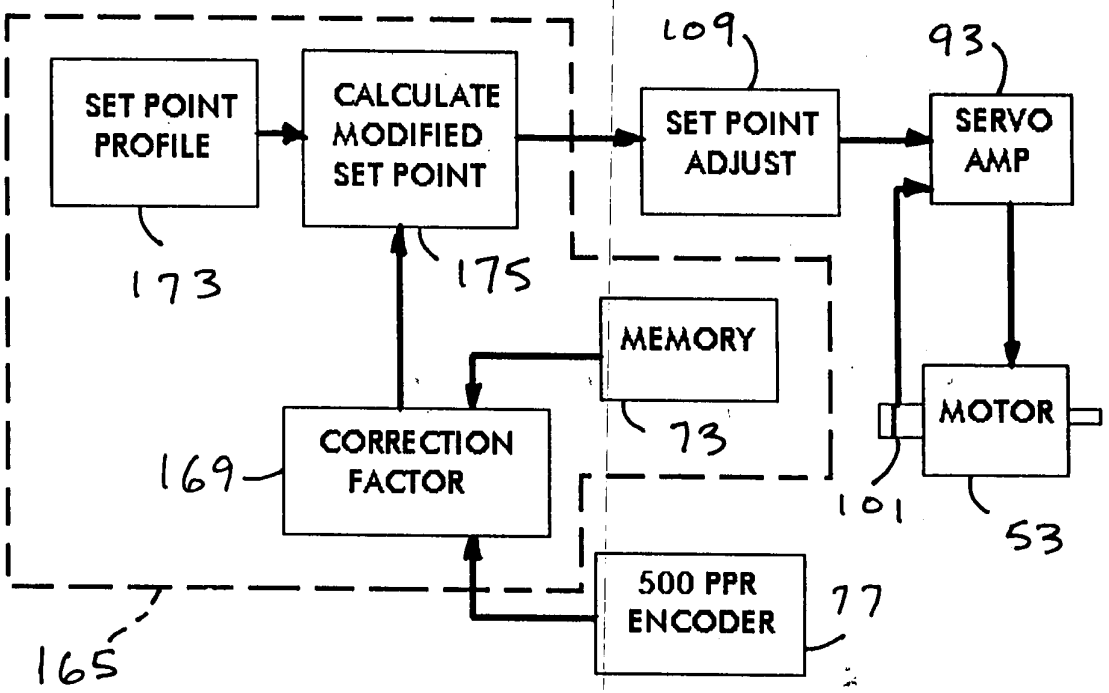

SET POINT PROFILE
CALCULATE MODIFIED SET POINT
SET POINT ADJUST
SERVO AMP
MEMORY
CORRECTION FACTOR
MOTOR
500 PPR ENCODER
173
175
109
93
73
169
101
53
77
165

FIG. 6A

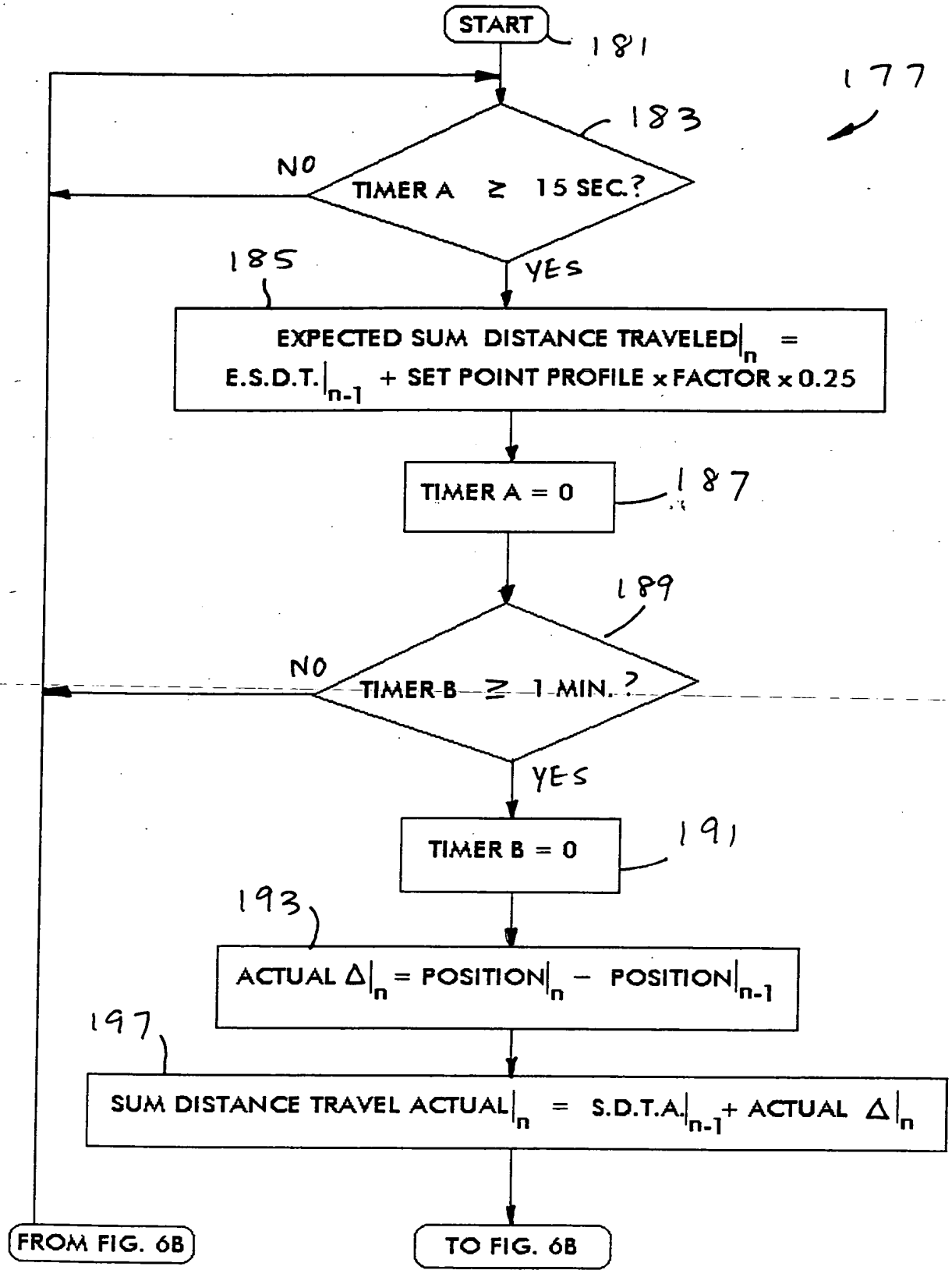
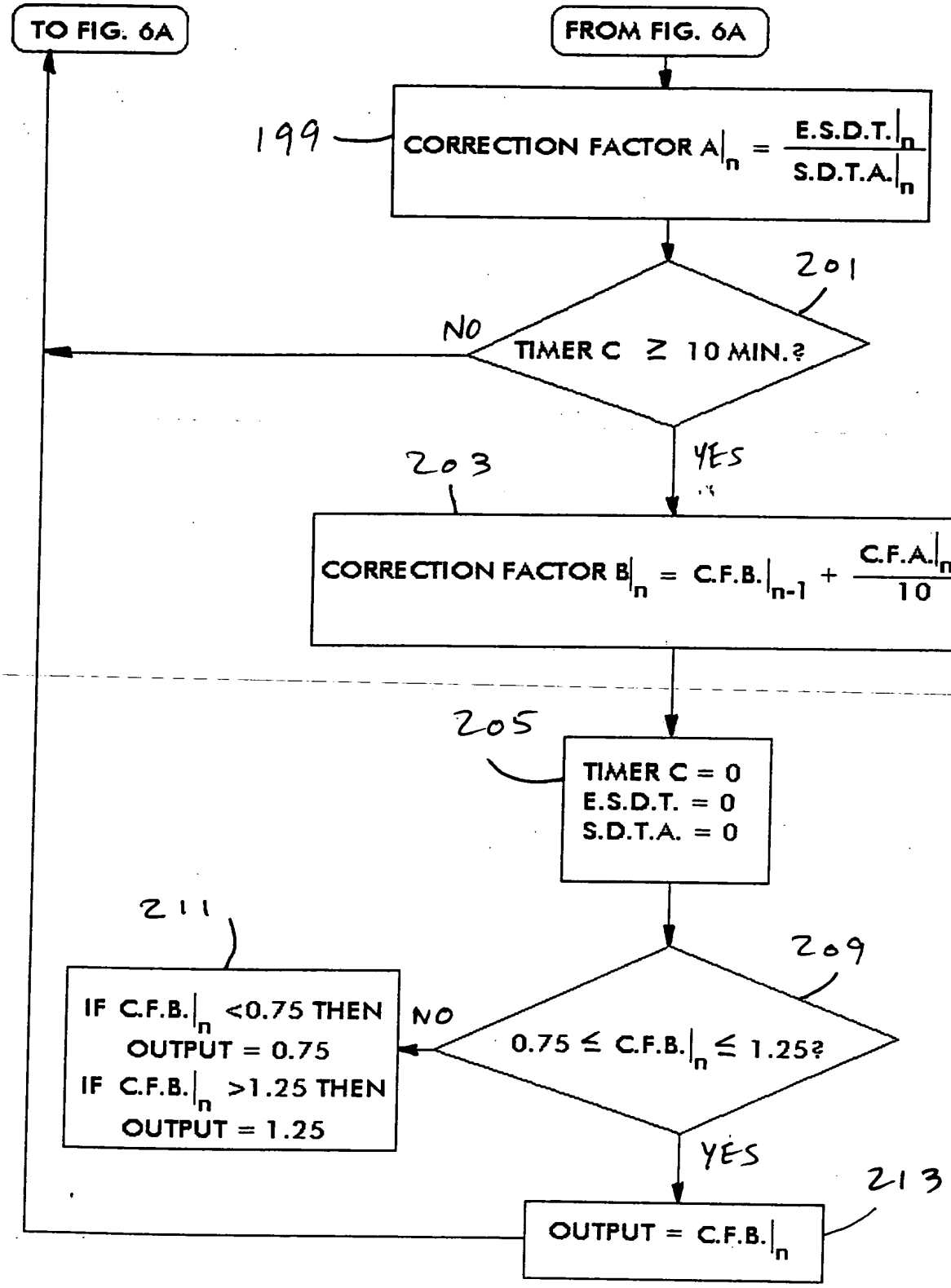

START
181
177
183
NO
TIMER A ≥ 15 SEC.?
YES
185
EXPECTED SUM DISTANCE TRAVELED|n =
E.S.D.T.|n-1 + SET POINT PROFILE x FACTOR x 0.25
TIMER A = 0
187
189
NO
TIMER B ≥ 1 MIN.?
YES
TIMER B = 0
191
193
ACTUAL Δ|n = POSITION|n − POSITION|n-1
197
SUM DISTANCE TRAVEL ACTUAL|n = S.D.T.A.|n-1 + ACTUAL Δ|n
FROM FIG. 6B
TO FIG. 6B

FIG. 6B


TO FIG. 6A
FROM FIG. 6A
199
CORRECTION FACTOR A|n = E.S.D.T.|n / S.D.T.A.|n
201
NO
TIMER C ≥ 10 MIN.?
YES
203
CORRECTION FACTOR B|n = C.F.B.|n-1 + (C.F.A.|n - 1) / 10
205
TIMER C = 0
E.S.D.T. = 0
S.D.T.A. = 0
211
IF C.F.B.|n <0.75 THEN OUTPUT = 0.75
IF C.F.B.|n >1.25 THEN OUTPUT = 1.25
209
NO
0.75 ≤ C.F.B.|n ≤ 1.25?
YES
213
OUTPUT = C.F.B.|n

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Diameter Control Loop -- Seed Lift

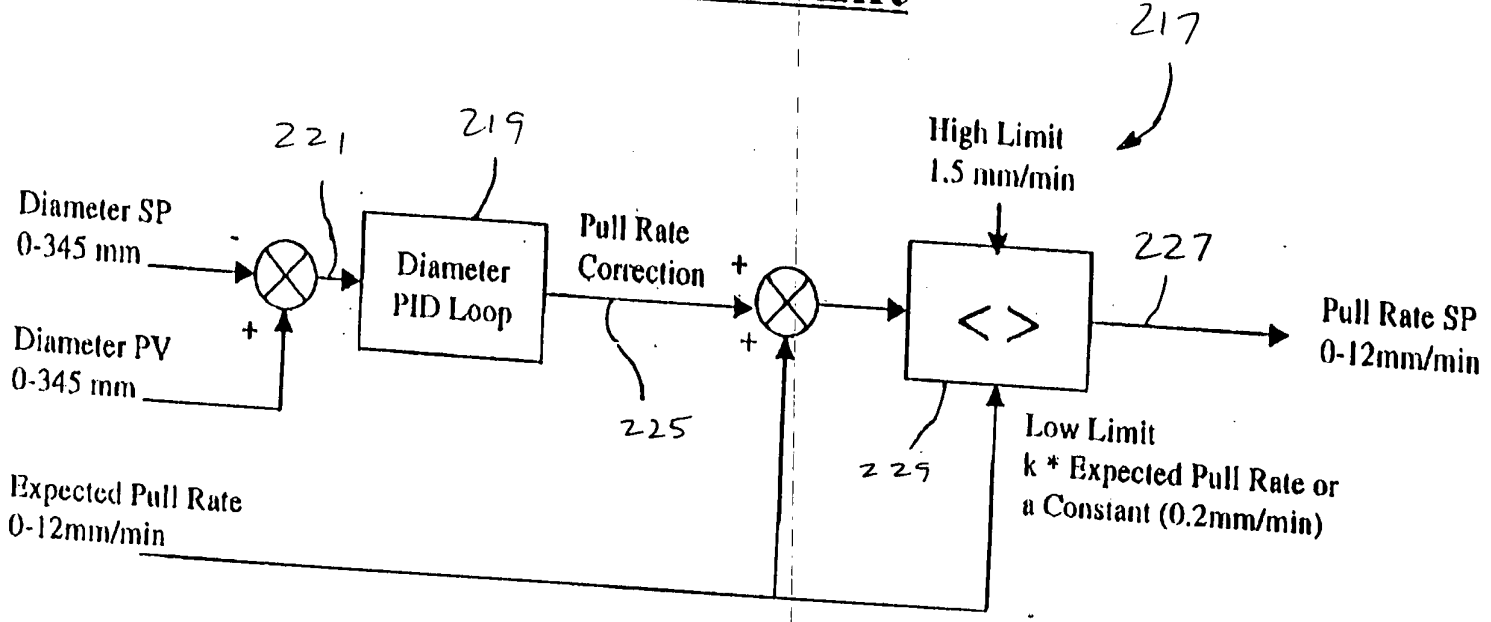


FIG. 7

PRIOR ART

FIG. 8 PRIOR ART

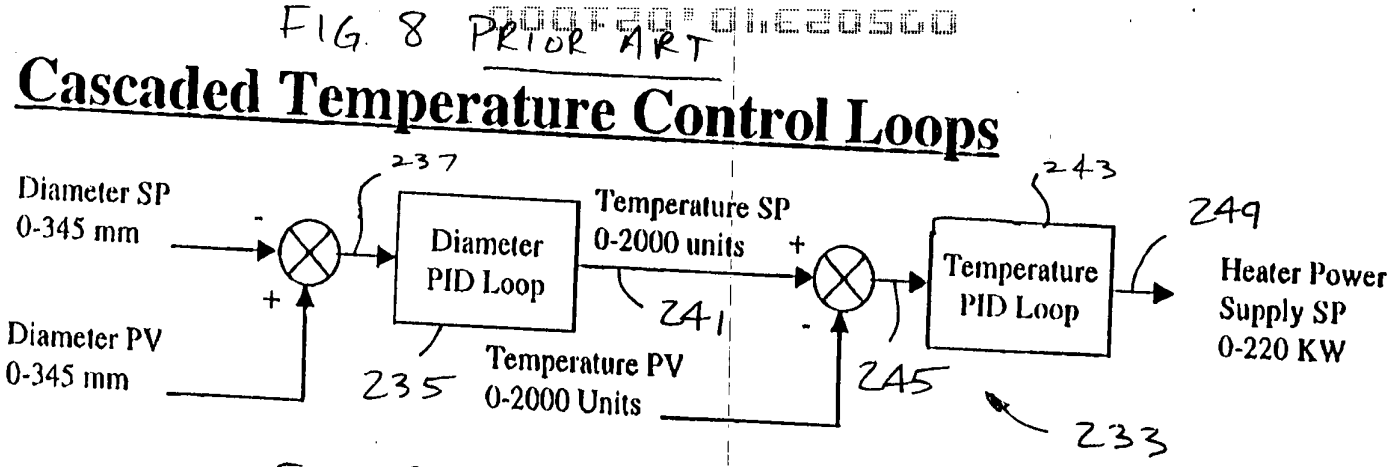


FIG. 9 PRIOR ART

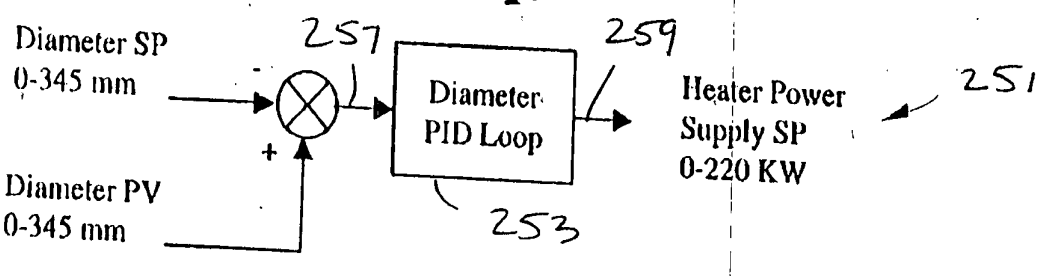


FIG. 10

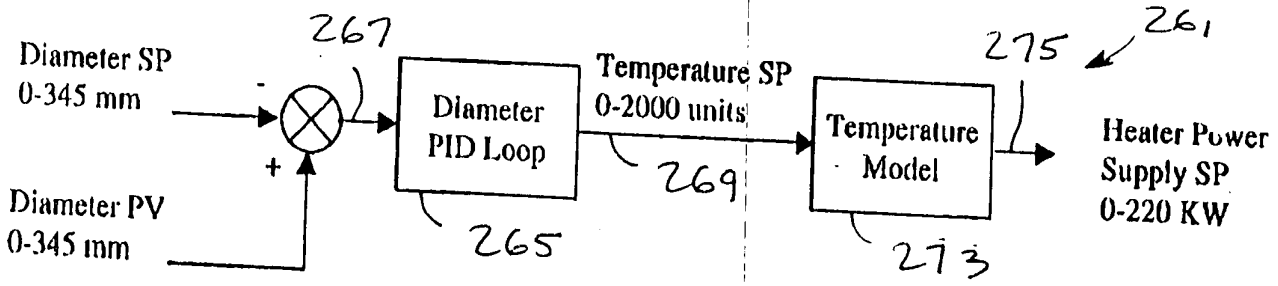
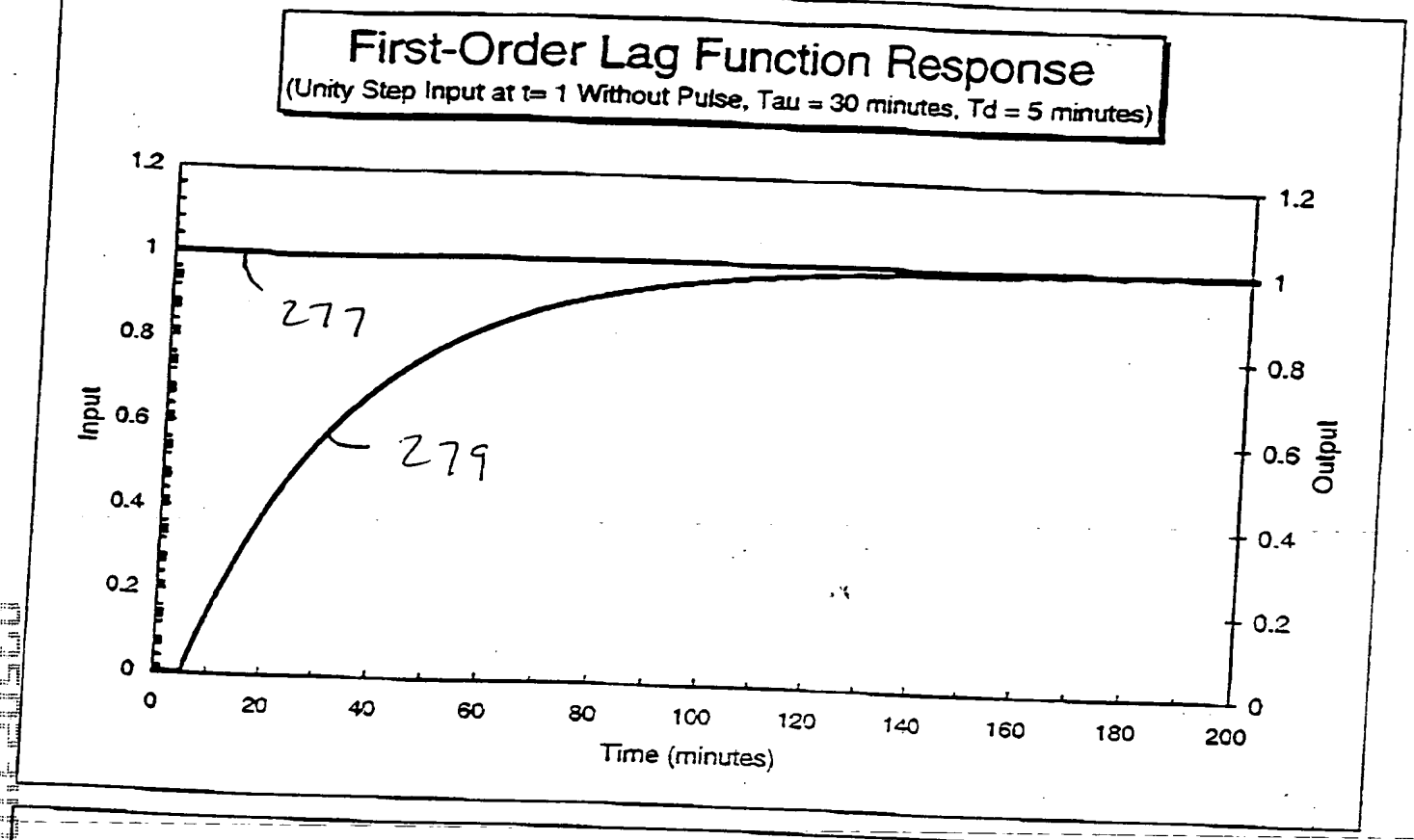


FIG. 11 PRIOR ART



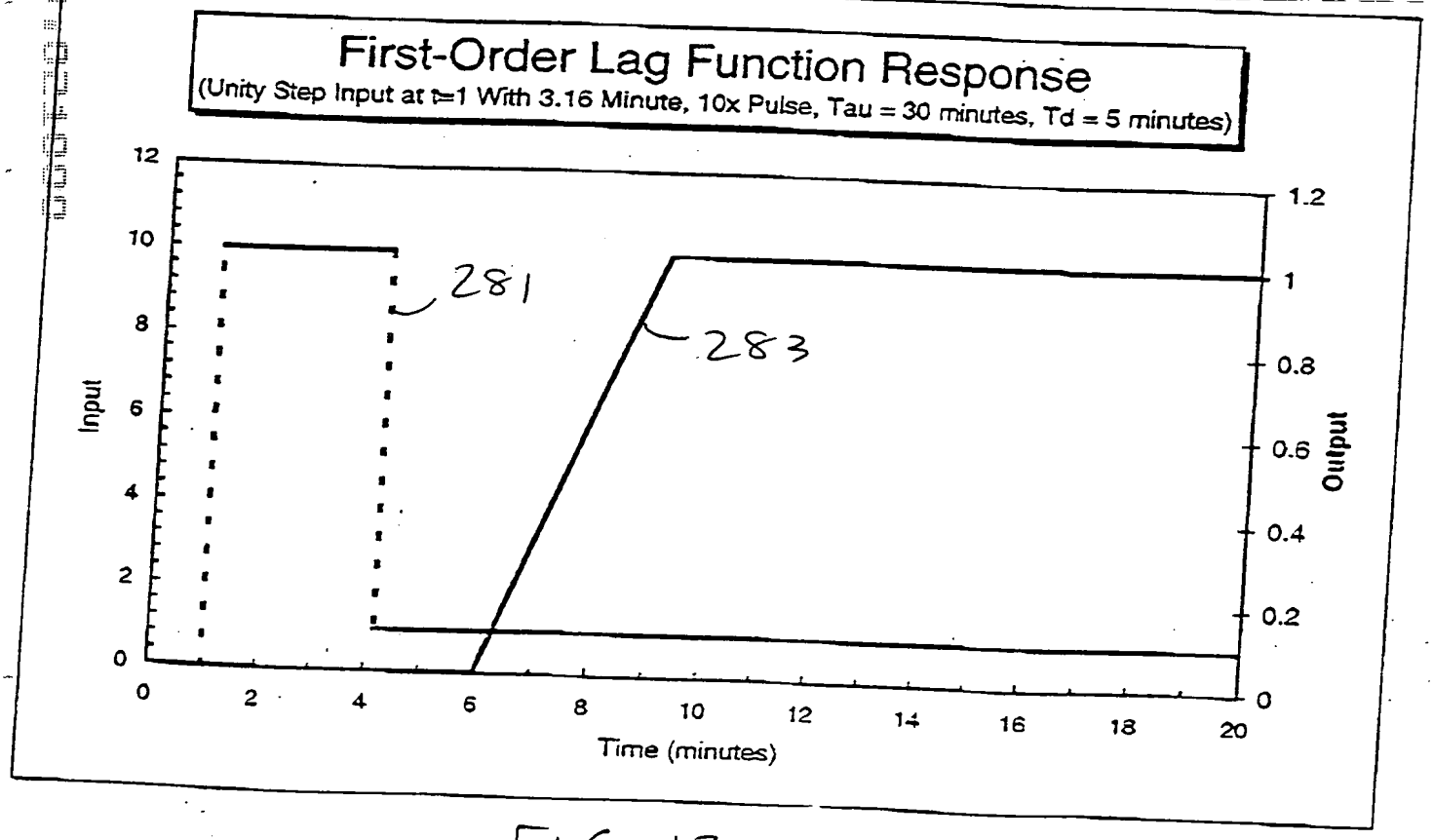
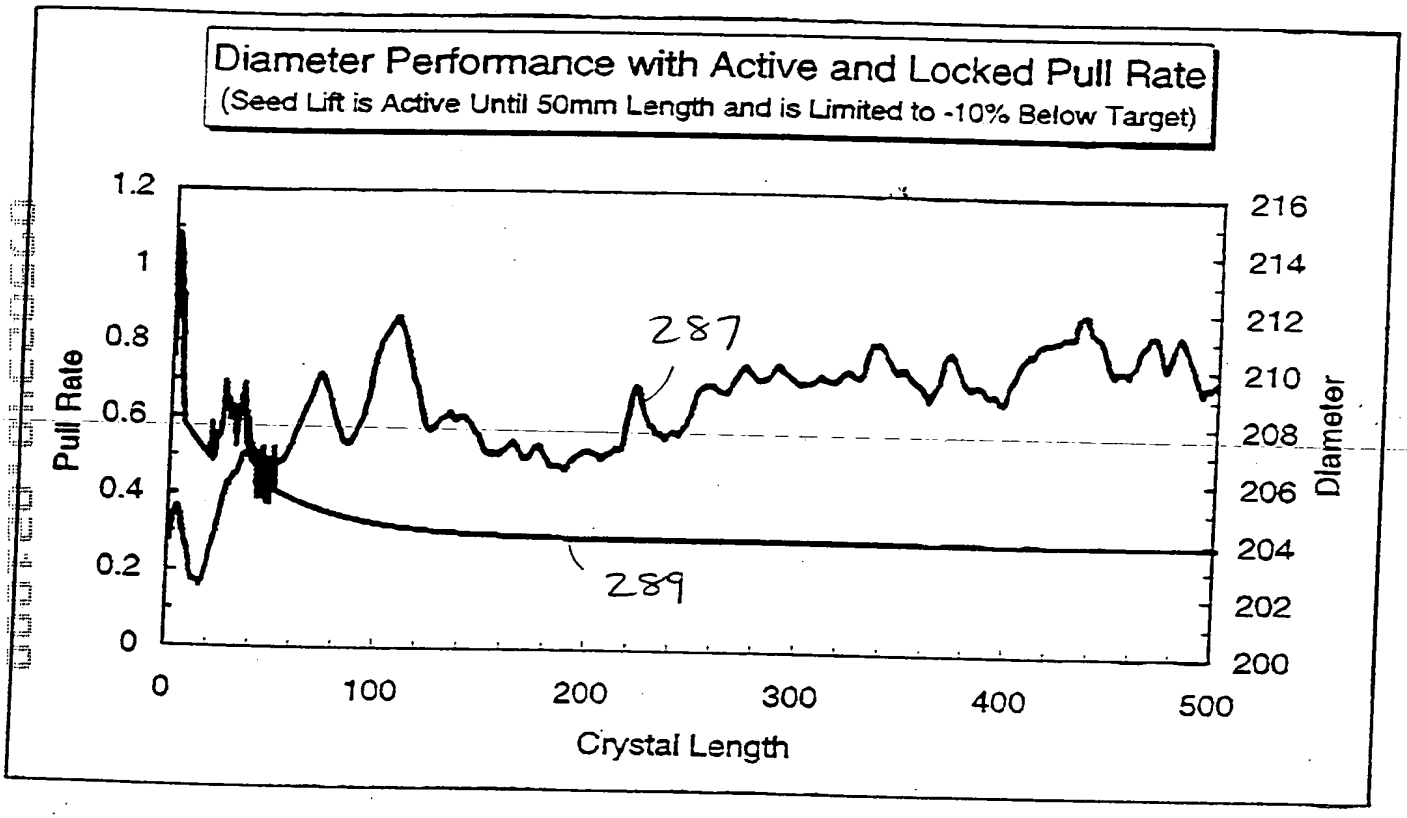


FIG. 12

FIG. 13


Diameter Performance with Active and Locked Pull Rate
(Seed Lift is Active Until 50mm Length and is Limited to -10% Below Target)
Pull Rate
1.2
1
0.8
0.6
0.4
0.2
0
Diameter
216
214
212
210
208
206
204
202
200
287
289
0
100
200
300
400
500
Crystal Length